Method and system for providing cellular communication services

FIELD OF THE INVENTION

The present invention relates generally to mobile telephone systems. More particularly, the present invention relates to a method for location of cellular network subscribers, and providing or denying cellular communication services based on subscriber location. The location of a mobile telephone within the geographic serving area of a mobile telephone systems is determined, and the system enables various services based on a defined geographic service scheme.

BACKGROUND OF THE INVENTION

Mobile telephone systems, also referred to as cellular telephone systems, have become increasingly popular. These systems are generally made up of cell sites, each of which serves a coverage area, or cell. The cell site is the location within a cell which contains the required hardware (e.g. antenna(s) and radio base station) to communicate with the mobile telephones. A mobile telephone operating within a particular cell in the system communicates with the mobile telephone system through the cell site covering that cell. The various cell sites are connected to a Mobile Switching CenterMobile Switching Center which connects the mobile telephone system to the land-line telephone network.

The widespread use of cellular systems and the low cost thereof have many advantages, such as high availability and freedom from cables. However, various problems arise from the use of wireless mobile telephones.

One of the problems with using mobile telephones stems from the electromagnetic radiation emitted from such devices, which might affect susceptible equipment. Various health authorities prohibit the use of wireless communications devices in hospitals.

Another problem associated with the use of cellular telephones arises when subscribers receive calls when attending activities requiring silence. Most cinemas and concert halls request their guests to shut-down all pagers and cell-phones before the beginning of the show.

It is well known in the prior art that preventing use of cellular mobile phones may be implemented by transmitting a jamming signal on the control channels frequencies transmitted by the cellular system, thereby disabling the mobile unit from communicating with the cellular system.

The jamming method for enforcement of cell-phone usage policy has several drawbacks. First, in order to jam the cellular control (or paging) channel(s) one has to transmit a blocking signal using the same frequency band used by the cellular operators. When transmitting the jamming signal, one has to take precautions not to interfere with cellular communications outside the controlled area. It is well known to a man skilled in the art that precise control of electromagnetic radiation is a complex and expensive task. Various countries have prohibited use of jamming equipment.

Second, by jamming all communications between the cellular system and the mobile unit, the subscribers are totally disconnected from the cellular network and cannot use any of the services offered by the cellular system. For example, in some places it may be desired for subscribers to receive paging and SMS services only, or to be able to perform urgent distress 911 calls. Completely jamming the control channels denies such services from all subscribers.

Present cellular systems partially provide indication of the cell site and/or antenna sector where a particular subscriber is located. Various location systems based on the cell site antennas provide more accurate information with respect to the mobile unit's position. However most cellular location methods are insufficiently accurate and cannot determine the mobile unit's exact position. The US Federal

Communications Commission (FCC) will require cellular operators to locate a mobile phone within a 125-meter radius by 2001(A project referred to as E911). To date none of the prior art location systems provides logical location, indicating a subscribers presence within the boundaries of a predefined area.

SUMMARY OF THE INVENTION

The present invention provides a method and system for enabling cellular communication services respective to several parameters, such as the current location of the mobile unit, time, and other attributes rendered to subscribers.

According to the present invention, the cellular system receives data regarding the mobile unit's location. The cellular system includes a location management unit comprising computer hardware and software to determine the type of service applicable in accordance with the subscriber's current location and profile and time of day. The management unit may be operated at the Mobile Switching CenterMobile Switching Center, or at the different base stations.

An objective of the invention is to provide a method and system for providing cellular communication services respective to user location and profile. In accordance with the premises management usage policy.

Another objective of the invention is to enable cellular operators to provide selective services to cell-phone users visiting in different locations such as hospitals, airplanes, cinema halls, military bases or otherwise secure locations etc. Thus, the cellular operator may provide only silent messaging to users who have entered a cinema hall, and may not provide any services to users who have entered a hospital, so as to prevent electromagnetic interference, or to users who have entered a secure facility in order to prevent compromise of premises security.

In accordance with another aspect of the invention, a front-end module is placed within a controlled area and reports to the cellular system which subscribers are located in the controlled area.

In accordance with another aspect of the invention, the front-end module increases the accuracy of other means for locating the position of cellular subscribers where the cellular system incorporates additional location capabilities.

In accordance with yet another aspect of the invention, the cellular system receives the location of the subscriber without any special action on the part of the mobile telephone or the mobile telephone user.

In accordance with another aspect of the invention, a clone base station front-end, positioned in the regulated area communicates with mobile cell-phones in the area, thereby controlling cell-phone's availability and operation mode.

In accordance with another aspect of the invention, a signaling device, activated in the regulated area, transmits a beacon signal, which is received by mobile phones located in said regulated area. As the Mobile Switching Center receives notification from mobile phones that said beacon signal is present, relevant subscribers are marked as located within the regulated area and can be denied services if so required.

In accordance with another aspect of the present invention, the mobile phone receives a signal from a local transmitter and relays said signal to a management system via the cellular switching center. The management system identifies the said signal's properties and extracts the mobile phone's location by processing various parameters related to said signal.

In accordance with another aspect of the present invention, a mobile phone incorporating a short range local transceiver ,such as an infra-red transceiver or a Bluetooth compliant transceiver or a HomeRF compliant transceiver, the mobile

phone receives a signal from a local transmitter and relays said signal to a management system via the cellular switching center. The management system identifies the said signal's properties and extracts the mobile phone's location by processing various parameters related to said signal.

In accordance with another aspect of the present invention, a mobile phone incorporating a short range local transceiver ,such as an infra-red transceiver or a Bluetooth compliant transceiver or a HomeRF compliant transceiver, communicates with corresponding transceiver thereby communicating with a local management system which enables a variety of services based on subscriber identity.

These and other advantages of the invention will be apparent to those of ordinary skill in the art by reference to the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and its numerous objects and advantages will become more apparent to those skilled in the art by reference to the following drawings, in conjunction with the accompanying specification, in which:

FIG. 1 is an illustrative diagram describing a typical cellular system composed of 7 cell sites, each having a base station incorporating a transceiver.

FIG. 2 is a functional diagram illustrating the components of a cellular system included in one embodiment of the present invention.

FIG. 3 shows a cellular telephone system regulated area location system in accordance with one embodiment of the present invention.

FIG. 4 is a block diagram of one preferred embodiment of the location system digital signal processing.

FIG. 5 is a flow diagram illustrating the steps performed by the present invention when a mobile user originates a call.

FIG. 6 illustrates the operation of a beacon device for location determination purposes.

FIG 7 is a flow diagram illustrating the typical steps performed by a management system in accordance with the present invention.

DETAILED DESCRIPTION

FIG. 1 illustrates a basic cellular system having 7 hexagonal cells numbered 1-7. Cell 7 is shown in the center, surrounded by adjacent cells 1-6. The serving area of a mobile telephone system would typically contain more than 7 cells, however, for ease of reference, only 7 cells are shown in FIG. 1. Each cell 1-7 contains a base station including a transmitter, receiver and base station controller as are well known in the art. The base station transmitter/receiver is connected to an antenna tower 11-17 which is used to transmit signals to, and receive signals from, mobile telephones, within the mobile telephone system serving area. In FIG. 1 the base stations antenna towers 11-17 are selected to be located at the center of each of the cells 1-7, respectively and are equipped with Omni-directional antennas. However, in other configurations of a cellular radio system, the base station towers 11-17 may be located near the periphery, or otherwise away from the center of the cells 1-7 and may illuminate the cells 1-7 with radio signals either Omni-directionally or directionally. Therefore, the representation of the cellular radio system of FIG. 1 is for purposes of illustration only and is not intended as a limitation on the possible implementations of a mobile radio communications system within which a regulated area is defined for the purpose of locating subscribers and providing location oriented services. A regulated area 10 is located within cell 7, and a plurality of mobile units are used across the entire serving area within cells 1-7. Again, only one regulated area is shown in FIG. 1, but it should be understood that the actual number of regulated areas can be larger, in practice.

Each cell 1-7 has assigned to it a plurality of voice or speech channels for transmitting and receiving voice signals, and at least one access or control channel for transmitting control data signals, such as a forward control channel, and receiving control data signals from the mobile units, such as a reverse control channel. Referring to FIGS. 1 and 2, consider mobile telephone unit 22 which is operating in cell 7. The mobile unit 22 is communicating over the air interface

with the mobile telephone system via base station antenna 24. Voice signals are communicated between the mobile unit 22 and the antenna 24 via one of the cell's voice channels, and control data signals are communicated between mobile unit 22 and the antenna 24 via the cell's control channel. The control channel is used to control or supervise the operation of the mobile unit by means of information transmitted and received from these units, referred to as messages. Control and administration messages within a cellular radio system are sent in accordance with industry established air interface standards, such as AMPS and EIA/TIA 553, the standards for analog cellular operations, and/or D-AMPS, IS-54 and IS-136, the standards for digital cellular operations, all of which are hereby incorporated by reference herein. Similar standards such as IS-95 for Code Division Multiple Access (CDMA) and Global System for Mobiles (GSM) govern other geographic areas throughout the world, and are well known to those skilled in the art.

A mobile telephone system in accordance with one embodiment of the present invention is shown in FIG. 2. The mobile unit 22 is a digital mobile telephone which operates according to the North American Time Division Multiple Access (TDMA) system IS-55 standard, and the air interface is described by the IS-54 and IS-136 standards. See, EIA/TIA Interim Standard IS-54-B "Cellular System Dual-Mode Mobile Station--Basestation Compatibility Standard", April, 1992; EIA/TIA Interim Standard IS-136 " Cellular System Dual-Mode Mobile Station--Basestation: Digital Control Channel Compatibility Standard", April, 1995. Each cell 1-7 within the mobile telephone system serving area contains a cellular base station antenna tower 24 which is connected to the Mobile Switching Center 25.

In such a situation, cell 7 is the serving cell since the voice data is being communicated through that cell. In addition to the communication with the serving cell, the mobile unit 22 also monitors the control channels of nearby cells.

The information exchanged between base stations and mobile units via messages, may include incoming call signals, outgoing call signals, paging signals, paging response signals, location registration signals, voice channel assignments, maintenance instructions and handoff instructions as the mobile units travel out of the radio coverage of one cell and into the radio coverage of other cells, as well as other additional items of information such as calling party numbers, time information and the like. The control or voice channels may operate in either analog or digital mode or a combination thereof based upon industry standards.

The regulated area 21 is located within the coverage area of the cell site. The mobile unit 22 shown within the regulated area communicates with the cellular base station 24 via an air interface. A front-end module 23 is installed within or near the regulated area 21. The front-end module monitors the radio messages transmitted by the mobile unit 22 and determines if the unit is located within the regulated area. The front-end module 23 communicates with the cellular base station 24 via the reverse control channel or any other communications means, and notifies the Mobile Switching Center 25 of all mobile units currently located within the regulated area. The Mobile Switching Center 25 includes a service management unit (SMU) 26. The SMU includes software that runs and updates a database of all cellular subscribers current location and profile. And a data resulting in a digital map of regulated areas. The data received from the front end is compared to data from other sources, in order to improve the accuracy of the location coordinates. Thus it is determined whether the user is actually inside the regulated area. The SMU determines what services are currently available to each user. Whenever a mobile unit located within a regulated area requires service from the cellular system (e.g. initiates or receives a call), the Mobile Switching Center checks the user database if such service conforms with the defined usage policy.

Usage policy in regulated areas may differ in accordance with the Mobile Identification Number (MIN) or the Electronic Serial Number (ESN) resulting in

different services available to different mobile unit, as a function of the user location and profile definition.

Since various cellular operators use different methods for locating their subscribers, at various levels of accuracy, a disclosure includes an optional method and system for locating subscribers within defined areas. The describes location method may be used in addition to other location methods and systems in order to provide subscriber positioning services, and may not be required where the cellular system is able to derive accurate enough positioning data.

FIG 3. illustrates one embodiment of the present invention wherein a defined regulated area 31 are one or more mobile units. Only one mobile unit 32 is shown in FIG. 3, but it should be understood that the actual number of mobile units may be larger. The presence or absence of mobile units in any particular regulated area should be understood to depend, in practice on the individual desires of subscribers utilizing the mobile units. A plurality of mobile units, such as mobile unit 32 shown in FIG. 3 are used outside the regulated area 31. A front end unit 34 is located within or near the regulated area 31. The front end unit 34 incorporates an array of receiving antennas 35 comprising a plurality of antennas separated from each other so as to enable accurate intersection of the signals transmitted from the mobile units nearby the regulated area 31. In the illustrative example of FIG. 3, three receiving antennas 36-38 are utilized to determine the location of a mobile unit 32. While three receiving antennas 36-38 are utilized in the illustrative example of FIG. 3, it should be understood that a different number may be utilized in practice. The present invention monitors all messages transmitted by the mobile units located in the vicinity of regulated area 31 vis-a-vis the antenna array 35 connected to the front end unit 34. By measuring signal strength, propagation delay, or both from each of the receiving antennas 36-38, the distance of the mobile unit 32 from each antenna is calculated. Arcs of possible locations of the mobile unit are then derived from the calculated distances. Well known geographical intersection techniques such as triangulation, arculation, probability

density functions, and the like are then used to calculate the location of the mobile unit. The front end unit 34 converts the measured signal strength, propagation delay, or both from each of the antennas 36-38 into digital format and transmits the measured values to a nearby base station 39. In the preferred embodiment, all measurements from various base stations are relayed to the Mobile Switching Center, wherein a processor unit 30 calculates the location of all mobile units in the vicinity of regulated areas wherein a front end unit is installed. It should be understood that the location of the processor unit may be either within the front end unit 34 or within the base station 39 as well as the Mobile Switching Center 30. Preferred embodiments of the present invention make significant use of digital signal processing techniques. Such techniques entail the use of appropriate forms of sampling and conversion hardware to convert analog radio frequency signals into sampled digital data forms. These techniques are widely known in the art, and are capable of performing many functions traditionally implemented using analog components. The advantage of using digital signal processing includes better control of noise during conversion, sampling, and filtering; and exact replication of these functions from each receiving antenna. Since the front end unit serves as a conversion facility to digital signals, it becomes technically immaterial where the actual processing is performed. Thus, the digital measurements can be processed either within the front end unit or at any other location such as a base station or the Mobile Switching Center. Moreover, one skilled in the art will recognize that in a commercial implementation of the present invention, the actual location of the processor is a cost tradeoff involving the cost of digital signal processing subsystems and the cost of transferring the raw digital measurements from the front end units to the Mobile Switching Center.

FIG. 4 illustrates a typical location technique disclosed in U.S. Patent No. 5,608,410 to Stilp et al entitled "SYSTEM FOR LOCATING A SOURCE OF BURSTY TRANSMISSIONS CROSS REFERENCE TO RELATED APPLICATIONS", which is incorporated by reference herein. It should be noted that the present invention is not limited to the Stilp method and any other

sufficiently accurate location method can be utilized. Referring to FIG. 4, the front end unit is made up of an elevated ground-based antenna array comprising three antennas receives transmissions from mobile units over the reverse control/access channel, typically of the nearest cell site. Signals received by each antenna are fed into a sampler 41, which converts the sampled signals into frames of digital data at a prescribed sampling frequency. Each frame of data comprises a prescribed number of data bits and time stamp bits that represent the time at which the responsive signal was received. Baseband converters 42 receive the sampled signals and provide a baseband signal derived therefrom. A multi-antenna processor 43 combines and distinguishes the signals received from the individual antennas in the antenna array, and then provides a single representation of a signal for further processing. A transmission demodulator 44 determines the demodulated data content of the responsive signal, where the demodulated data content includes information identifying the mobile unit, possibly its electronic serial number (ESN) and/or mobile identification number (MIN). A database subsystem 45 determines how and whether a responsive signal should be stored for further processing, or whether it should be discarded. A signal processor 46 extracts selected signal characteristics from the frames of digital data, such as timing, power, frequency and phase. A data reduction and forwarding subsystem 47 selects and compresses the data frames before transmission over communications facilities to the central site (Mobile Switching Center). A timing module 48 determines a synchronization signal common to all the antenna site components. The system is self-calibrated by a calibration module 49 which determines and corrects changes in delay, frequency and phase of various site components.

FIG. 5 is a flow diagram illustrating the steps performed by the SMU when a mobile phone subscriber originates a call when located in the regulated area. The system begins in FIG. 5 at step 51 where a user originates a call to a land subscriber. As the user's request for service is received, the system moves to step 52 and checks the user's position ,and optionally updates it with new data. At step

53 the SMU determines the accuracy of the user's location. If the system determines that the user's location is not sufficiently accurate then the system moves to step 57 and provides the default level of service or a level of service defined for inaccurate positioning in the vicinity of the regulated area . If it is determined that the user's location is accurate the system proceeds to step 54 and determines the defined usage policy for the user's location. If at step 54 it is determined that the user's current location is not defined as having a specific usage policy then the system moves to step 57 and provides the default level of service. If, at step 54 it is determined that the user's current location has a defined usage policy then the system proceeds to step 55 where it is determined if the said user (or user group) has a specific permission which overrides the general definitions of the level of service available in the regulated area. If at step 55 it is determined that the user has a specific permission, then the system moves to step 58 and provides the level of service designated to said user. If, however, at step 55 it is determined that said user does not have a specific permission, then the system proceeds to step 56 where the service rendered to the user is determined in accordance with the usage policy defined to its current location. The steps illustrated in FIG. 5 are followed both when the service is initiated by the mobile user or when the user is totally passive and the call or message is initiated by another subscriber, whether mobile or land based.

Table 1 describes a basic usage policy database for a cellular system in accordance with one embodiment of the present invention. Line 1 sets the basic rule - all subscribers are allowed access to all services at all time. Line 2 denies all cellular services from all subscribers located within the hospital at all time. Lines 3 and 4 limit all subscribers located at the concert hall (except 245677) to SMS services only during the concert time (22:00-24:00). Line 9 provides additional services to User 518603 when located in the company factory area, including wider bandwidth for network connection and video conferencing, better quality of service, reduced price, conference call service etc.

Table 1

No.	Subscriber MIN	Location	Time	Services Allowed	Services Denied
1.	ALL	ALL	ALL	ALL	
2.	ALL	Hospital	ALL	SMS	ALL
3.	ALL	Concert hall	22:00-24:00	SMS	ALL
4.	245677	Concert hall	ALL	ALL	
5.	ALL	Cinema	22:00-24:00	SMS	ALL
6.	230882	Cinema	ALL	ALL	
7.	ALL	Public library	ALL		ALL
8.	586362	Public library	ALL	ALL	
9.	586362	Company factory	ALL	ALL+64kbps Bandwidth	

Similarly, the availability and price of additional services may be determined respective to MIN and user profile definitions versus, user current location and regulated areas database.

In one embodiment of the present invention, areas such as corporate office buildings are divided into sections. The SMU manages communications services and resources according to user location.

The SMU receives user location data as described, and sends commands to the Mobile Switching Center, and other subsystems of the cellular network, to determine the services to be provided to users in the designated location. Therefore, when a mobile cellular subscriber enters designated areas, incoming calls may not be directed to the user cell-phone at all, or may be redirected as an incoming call to the nearest available wireline telephone extension. SMU may also manage and control the availability of resources managed by the corporate

premises therein. In order to control availability of resources managed by the corporate, the SMU typically communicates via the cellular telephone network with a resource management unit at the corporate office building. For example, the SMU detects the presence of a specific user in the office and (1) signals to the computer via the wireless network to grant/deny access to computer applications, networks and files and determines database permissions; (2) Similarly, by communicating with a control unit, by means of wireless modem, the SMU enables or disables specific auxiliary services and resources available in said designated area, such as managing availability of equipment, printers, lab equipment , communication and video conferencing utilities etc; (3) The SMU, via wireless network and control unit at the corporate end ,equipped with wireless modem, may allow/deny physical access to specific rooms;(4) grant/deny access to classified information in physical cabinets; (5) determine employee presence at the office and perform time logging; (6) and broadcast general messages pertinent to users in specific locations, such as messages regarding fire alarm, security alarm etc.

It should be understood that the Services Management Unit (SMU) software typically located at the Mobile Switching Center, may be located in the regulated area and communicate with cellular network Mobile Switching Center or base stations as required. For example, the detailed description described a method for calculating a location estimate by using three signal strengths. However, the principles of the present invention could be extended to perform such a calculation using more than three signal strengths, or different means for calculating the estimated location of the mobile unit Such an extension could be readily implemented by one of ordinary skill in the art given the above disclosure. The presence of the cell-phone in the regulated area may also be established by detecting the cell-phone using a positioning front end as a registry at the entrance, corridor, or gate to the regulated area. The SMU will than extract a database of the actual position of the cell-phone users at any given time according to the gates

they passed and the positioning front end they have communicated with upon entering and exiting regulated areas.

In another embodiment selective, location orientated control of cellular services is achieved by positioning a phantom base station in the controlled location. The phantom base station simulates base station signaling in order to communicate with the mobile phones in the location. The mobiles in the controlled location receive the clone signaling from the nearby transmitter at a superior signal to noise ratio, and respond to the clone signaling rather than to the actual cellular system base station. the clone station simulates signaling respective to the required control and limitation of cellular services in the controlled area. The clone station is capable of performing cell-phone registration, transmitting protocol signals that disable all mobiles from receiving incoming calls, and transmitting protocol signals that disable selected services only. In a typical embodiment said base station as a singlr board inserted into a Personal Computer's expansion slot or in part by using the PC's main processing unit, so as to enable cost effective design, minimum power requirements. easy to use interface and integration with the PC operating system providing numerous advantages . Such implementation can benefit from the PC's resources such as Hard disk and Internet Local Area Network and phone line connectivity.

A clone station receiver enables simulated communication with cell-phones. The receiver enable the clone station to recognize cell-phones with specific Mobile Identification Numbers (MINs), predefined in the clone station database, referring these selected users to use the actual base station operating in that area. The selected users will still receive regular cellular services, and will be capable of receiving incoming calls and other services.

In another embodiment, a method for determination of the location of a mobile subscriber is presented, by which a Mobile Switching Center (MSC) is able to determine that certain cell-phones or Mobile Stations (MS) are located within a

predefined area. The method involves transmission of a low power signal or signals in the spectrum in which the base station signals are transmitted (e.g., 935 – 960 MHz for GSM, or 869-894 MHZ for IS 136). This signal will be received by an MS close to the transmitting device (within the area defined). The MS then transfers information pertaining to this signal to the Base Station (BS), and the MSC. The MSC Location Software (MLS) uses a database of the signals received in each covered area, analyses the signals received by the MS, and calculates the MS location. Thus, the MLS is able to determine the location of the MS according to the transmissions received from it. The MS location calculated by the MLS, is 'functional' or 'logical', and not limited to geographical coordinates or area. For example, the beacon is set to transmit a weak signal received only within a concert hall. The MLS learns which mobile stations receive the signal and in turn concludes which MS are within the concert hall The MLS than instructs the MSC which services to provide to the MS in that given area . For example, in Hospitals MSC may provide only Short Messaging Services. When the MS exists the regulated area, the signal transmitted by the beacon or phantom base station is attenuated , and is not received in an adequate level by the MS. The measurements performed by the MS and forwarded to the cellular network vary according to cellular standard specifications. For instance, IS-136 handsets measure RSSI and/or BER based on the channel being measured. GSM handsets report a list of six strongest non-serving BCCH channels received. Thus, the exact type of beacon signal varies in order to conform to the handsets, with which the beacon interacts. Beacon signals conform to system measurements and reports executed as per the respective standard.

Several types of transmissions may be used in order to relay information via the MS,BS, and MSC to the MLS. Any transmission which will result in specific data reported to the BS and MSC(e.g. list of frequencies or a list of control channels received by MS, and signal measurements and parameters, as described in GSM 04.08) may be used. Similarly, any transmission resulting in a pattern in the reports received by the MSC (e,g. transmission of a very weak jamming signal

periodically, resulting in a pattern in the signal strength reported) ,the pattern being identifiable by the MLS, may be used.

In the preferred embodiment the detection of the beacon signal (or signals) by the MS is made within the handset by using Mobile Assisted Hand-Off (MAHO) functions, such as those implemented by IS-136 cellular systems and GSM. The MAHO function requires a mobile station to furnish RF-channel signal quality information to its serving base station. A detailed description of the MAHO function can be found in TIA/EIA/IS-136.2-A section 2.4.5.

Using MAHO, an MS establishes a dynamic table of control channels of adjacent cellular base stations and their respective received signal strength levels. The MAHO list is typically used to select the best suitable cell, to which an MS will perform handoff upon radio link degradation with current serving cell. The MS updates the cellular system of changes in the MAHO list.

In the preferred embodiment, a phantom base station transmits control channel signaling on a frequency not used by the base stations received in the regulated area. The transmission power is calibrated so as to be received within a certain distance from the phantom base station, in which the use of cell-phones is to be regulated (e.g. 10 mWatt). The phantom beacon signal represents a phantom cell The beacon channels correspond to the MLS database. The MLS associates MAHO list patterns with typical areas and service policies. The MLS The MLS identifies the channels at which the phantom base station is transmitting among the frequencies listed in the MS message, and determines that the relevant MS is within the designated regulated area. Further parameters may be incorporated into the beacon signal, where applicable. For example, a base station's ID number may be used to enable the MS to relate a certain mobile station with a specific location.

FIG. 6 describes a geographical area covered by several base stations. Part of this area, typically limited by walls is to be defined as a regulated area 60 in which, at certain times, only certain services are to be provided, and others are to be denied.

Inside the area one or more phantom beacon frequencies Fd1 and Fd2 are transmitted by phantom base station 64. Three base stations 61-63 are dispersed in the area. Two mobile stations are being used, 65 is inside area 60 and mobile station 66 is outside that area. Beacon transmitter 64 transmits one or more beacon frequencies (e.g., Fd1 and Fd2). Each of the base stations transmits a control channel frequency F1-F3. MS 66 will report frequencies of the adjacent base stations: F1, F2 and F3 (In this approximate order). MS 65 inside area 60 report will be: F1, F2, F3, Fd1 and Fd2. The phantom beacons signals Fd1 and Fd2, which are weak, and detected or received at a minimal signal strength only by MS 65 due to the proximity thereto and the RF attenuation provided by the boundries of area 60. MS 66 will not receive signals Fd1 or Fd2 and will not include those channels in its adjacent cell list. Alternatively, MS 66 receives signals Fd1 or Fd2 and includes them in the MAHO list The MSC, which receives a MAHO message. The MLS can then determine that MS 65 is located inside the area 60, and instruct the MSC to handle it according to predefined rules. In the presented embodiment, the MSC includes a user database such as in Table 1, which further comprises a database of regulated areas wherein phantom channels are transmitted. Upon receipt of a MAHO message by the MSC the list is transferred to the MLS which compares the MAHO list, with a mask of phantom frequencies, which would not have been received inside or outside a given area. The phantom frequency selection should be made in conjunction with the said cellular system frequency re-use plan, while making sure that phantom beacon channels do not interfere with normal cellular communication services.

The beacon transmitter device typically implements the transmit path of a cellular base station, which is well known to those skilled in the art. A single carrier frequency cellular base station design is disclosed in U.S. Patent No. 5,812,955 to Dent et al entitled "BASE STATION WHICH RELAYS CELLULAR VERIFICATION SIGNALS VIA A TELEPHONE WIRE NETWORK TO VERIFY A CELLULAR RADIO TELEPHONE". It should be understood that the

location method described herein can be utilized in order to enhance other location systems such as E911.

Another aspect of the foregoing embodiment involves the use of a mobile phone, which is configured to receive a signal or set of signals transmitted from nearby transmission devices. The mobile phone is further configured to relay said signal to the MLS so as to enable the latter to process the information and derive said mobile phone's location. The configuration change of the mobile station may be implemented by changing the system software executed by the mobile station's micro-controller or when applicable, by downloading the appropriate software into the Subscriber Identification Module (SIM).

The use of a GSM SIM card may be in accordance with the SIM Toolkit standard, as defined in Digital cellular telecommunications system (Phase 2+); Specification of the SIM application toolkit for the Subscriber Identity Module - Mobile Equipment (SIM - ME) interface (GSM 11.14 version 5.9.0 Release 1996). Such implementation may involve modification of the handset system software so as to monitor a predefined local transmission during discontinuous reception (DRX) intervals intended for low battery consumption. The received signal may then be used by the SIM application and/or forwarded to the MLS through any transport mechanism such as SMS.

In another embodiment, a mobile station incorporates a short-range transceiver that uses either infrared or spread spectrum transmission such as Bluetooth or HomeRF Shared Wireless Access Protocol (Cordless Access). In such embodiment, a mobile station communicates with a local management system via said short-range transport means, while enabling the local management system to render services depending on the identity of a particular subscriber and/or other parameters stored in the mobile station's memory. Such services may include control over various appliances, access control to doors, cabinets, safe storage spaces, network access, computer workstation user verification etc.

The mobile handset's operating software can be further configured to perform certain actions upon receiving commands from a local management system through a short-range transport mechanism. Such commands may include speaker mute, MS shut down, switch from ring to vibrate mode etc. In yet another embodiment, a messaging center is incorporated into the Service Management Unit (SMU). When a mobile subscriber is located within a regulated area and the usage policy defined for said subscriber denies voice communications, the user is normally unavailable. Subscribers having voice mail messaging services can route the incoming call to their personal mailbox. However, subscribers who do not have voice mail messaging remain unavailable. The present invention incorporates an autonomous messaging system, intended for cellular subscribers who do not have a personal mailbox. When a non-voice mail cellular subscriber located within a regulated area is called, the messaging system enables the caller to leave a message in a temporary mailbox. When the non-voice mail cellular subscriber departs the regulated area, the messaging system calls the non-voice mail cellular subscriber and notifies him that one or more messages are available for him. In cellular systems where a Calling Party Pays (CPP) billing scheme is implemented, the charges for the messaging service may be billed to the calling party, at his consent. Alternatively, the voice mail message may be handled by the non-voice mail cellular subscriber as a collect call, which has to be specifically accepted in order for billing to take place. It should be understood that the messaging system presented herein may provide services for voice, fax, data and video. The messaging system may be implemented within a wireline telephony system.

The foregoing detailed description is to be understood as being in every respect illustrative and exemplary, but not restrictive, and the scope of the invention disclosed herein is not to be determined from the detailed description, but rather from the claims as interpreted according to the full breadth permitted by the patent laws. It is to be understood that the embodiments shown and described herein are only illustrative of the principles of the present invention and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the invention